Title: Mortality, causes of death, years of life lost, years lived with a disability, and disability-adjusted life years in the countries of the UK and 150 English Local Authority areas 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016.

Authors: Nick Steel, John A. Ford, John N. Newton, Adrian Davis, Theo Vos, Mohsen Naghavi, Scott Glenn, Andrew Hughes, Alice Dalton, Diane Stockton, Ciaran Humphreys, Mary Dallat, Jurgen Schmidt, Julian Flowers, Seb Fox, Ibrahim Abubakar*, Rob Aldridge*, Carol Brayne*, Traolach Brugha*, Simon Capewell*, Josip Car*, Cyrus Cooper*, Majid Ezzati*, Felix Greaves*, Roderick Hay*, Simon Hay*, Frank Kee*, Heidi Larson*, Ronan A. Lyons*, Azeem Majeed*, Martin McKee*, Salman Rawaf*, Harry Rutter*, Sonia Saxena*, Aziz Sheikh*, Liam Smeeth*, Russell Viner*, Stein Emil Vollset*, Hywel Williams*, Charles Wolfe*, Anthony Woolf*, Chris Murray

*Authors listed alphabetically

Summary

Background

Previous studies have reported national and regional Global Burden of Disease (GBD) estimates for the UK. Because of marked variation in health within the UK, action to improve it requires comparable estimates of disease burden and risks, at individual country and at local level. The recent slowdown in the rate of improvement in life expectancy is of concern and requires further investigation.

Methods

We estimated years of life lost (YLLs), years lived with disability (YLDs), disability-adjusted life years (DALYs), and attributable risks from 1990 to 2016 for England, Scotland, Wales, Northern Ireland, the UK, and 150 English Upper-Tier Local Authorities as part of the GBD Study 2016. We estimated the burden of disease by cause of death, condition, year, and sex. We analysed the relationship between burden of disease and socio-economic deprivation using the Index of Multiple Deprivation.

Findings

The leading causes of age-adjusted YLLs in all UK countries in 2016 were ischaemic heart disease, lung cancers, cerebrovascular disease, and chronic obstructive pulmonary disease. Age-standardised rates of YLLs for all causes combined varied two-fold between local areas in England according to levels of socio-economic deprivation (from 14,274 per 100,000 people in Blackpool [95% uncertainty interval 12,791–15,875] to 6,888 in Wokingham [6,145–7,739]). Some Upper-Tier Local Authorities, particularly in London, performed better than expected for their level of deprivation. Allowing for differences in age structure, more deprived Upper-Tier Local Authorities had higher attributable YLLs for most major risk factors in the GBD. The population attributable fractions for all-cause YLLs for individual major risk factors varied greatly across Upper-Tier Local Authorities.

Life expectancy and YLLs have improved more slowly since 2010 in all UK countries. In 11 of 150 Upper-Tier Local Authorities, YLLs increased after 2010. For attributable YLLs, the rate of improvement slowed most clearly for cardiovascular disease and certain cancers, and showed little change for dementia.

Morbidity makes an increasing contribution to overall burden in the UK compared to mortality. The age-standardised UK DALY rate for low back and neck pain (1795 [1,258–2,356] per 100,000 per year) was higher than for ischaemic heart disease (1200 [1,155–1,246]) or lung cancer (660 [642-679]). The leading causes of ill health (YLDs) in the UK in 2016 were low back and neck pain, skin and subcutaneous diseases, migraine, depressive disorders and sense organ disease. Age-standardised YLD rates varied much less than equivalent YLL rates across the UK but local data on causes of ill health are limited.

Interpretation

These estimates at local, regional, and national level allow policy makers to match resources and priorities to levels of burden and risk factors. Improvement in YLLs and life expectancy slowed notably after 2010, particularly in cardiovascular disease and cancer, and targeted actions are needed if the rate of improvement is to recover. A targeted policy response is also required to address the increasing proportion of burden due to morbidity, such as musculoskeletal problems

and depression. Improving the quality and completeness of available data on these causes is an essential component of this response.

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Research in context

Evidence before this study

The Global Burden of Disease (GBD) Study has described the increasing contribution of non-fatal conditions to the burden of disease internationally and shown the importance of understanding geographic variations in disease, risk factors, and socio-economic deprivation. GBD has been used to generate subnational estimates in several countries to inform local priorities and practice. In the UK, policy and action to improve health requires comparable estimates of disease burden and risks at national and local authority level, but only regional estimates have been available from previous GBD rounds. Improvements in mortality are known to have slowed in the UK and other countries over a time scale that some have suggested implies a link with political, economic, and service factors in the UK. However similar changes have been seen in some other countries and the causes of the change in the UK remained unknown. The required policy response therefore remained uncertain. We know that sustained population level public health interventions can be effective and that benefits accrue both from prevention and improved treatment from health services.

Added value of this study

The contributions of individual conditions to years of life lost in the UK are quantified and compared for current policy-relevant geographies, the largest contributions being for ischaemic heart disease, lung cancers, cerebrovascular disease and chronic obstructive pulmonary disease. The extent to which the burden due to these conditions is attributed to specific potentially preventable risks is also quantified, including for example for tobacco use, poor diet, alcohol, obesity, and air pollution. Variation in burden between local areas is described and shown to relate strongly to levels of deprivation. Opportunity to reduce burden due to premature mortality by addressing specific risk factors is also shown to correlate strongly with deprivation. Non-fatal conditions are identified as increasingly important contributors to overall burden across the UK, particularly low back and neck pain, skin diseases, migraine, sense organ diseases, and depressive and anxiety disorders.

Updated GBD estimates show that the slow-down in rate of improvement in overall mortality rates in the UK since 2010 appears to be condition specific and largely driven by slow-down in the rate of improvement in mortality from cardiovascular disease and certain cancers.

Implications of all the available evidence

The extent to which the UK could reduce the overall burden of fatal and non-fatal conditions through effective prevention is described and quantified. The results identify and rank potential local, regional, and national priorities for action that would reduce burden and provide relevant support for local and national advocacy on such priorities. They should be a direct input to long term planning for health, for example the current 10 year plan for the NHS in England. Social and economic determinants of ill health remain an overriding concern and there is clearly a need for economic development and regeneration of poorer parts of the country, as well as a need for high quality health improvement programmes and care services in these areas.

As mortality continues to reduce albeit more slowly than before, ill health due to low back pain, skin diseases, sense organ diseases, and depressive disorders makes an increasing contribution to overall burden of disease. Local estimates of levels of ill health currently used to guide policy and practice could be improved and made more comparable by better use of existing data. Health records and linkage to survey data should be used more extensively to refine disease prevalence estimates, improve consistency between GBD and other sources and provide more reliable data to guide policy and programmes to address these causes of ill health and their sequelae.

Introduction

The Global Burden of Disease (GBD) project aims to produce the best possible comparable estimates of levels of ill health and injury around the world.[1] It is an annual global assessment of the health of populations, broken down by age, sex, country, and selected subnational geographic areas.[2-7] After 20 years of refinement, it makes a unique contribution to health policy and practice worldwide. [8,9]

Previous studies have reported GBD 2010 estimates for the UK,[10] and GBD 2013 estimates for nine English regions split by deprivation quintile.[11] GBD estimates of burden of disease have been used extensively at national level, for example by Public Health England (PHE), an executive agency of the Department of Health and Social Care, in its strategic planning and in its national health profile report,[12] and by Public Health Wales in its report *Health and its Determinants in Wales,*[13] which in turn informed Public Health Wales' strategic plan and also health service planning in Wales. The National Institute for Health Research has used GBD to assess the balance of their funded research portfolio.[14] GBD has also been used at a more granular level by bodies with an interest in addressing high burden conditions such as mental health and musculoskeletal diseases, and by local Directors of Public Health.[15] Scotland has recently undertaken its own independent burden of disease analysis.[16]

Developing estimates of burden of disease for smaller geographic areas than whole countries (subnational estimates) to aid local policy and practice is a priority for the GBD project.[17] In 2015, the UK[11] and Japan[18] were the first countries to publish subnational GBD estimates; India followed in 2016,[19] and subnational estimates have been presented for Brazil, Mexico, China, and the USA. Health policy is devolved in the UK and provision of services differs between the UK countries.[20] In England, Upper-Tier Local Authorities serving populations from 38,169 (Rutland) to 1,532,102 (Kent) have responsibility for maintaining and improving the health of their populations.[21] Levels of deprivation vary markedly between Upper-Tier Local Authorities. Local autonomy and scarcity of resources for public health action together generate a requirement for national and local estimates of morbidity and mortality to inform priority setting for public health and health services.

Several limitations of previous studies have been addressed through technical improvements and updates in GBD 2016. These include an expanded GBD cause hierarchy with 18 newly-specified causes of death and many new data sources. Updated GBD mortality information is of interest, as life expectancy improvement is known to have slowed in the UK and some other countries in recent years for reasons which remain unclear. It has been suggested that it could be due to reductions in welfare provision or even a systemic failure of social and health care in certain areas.[22,23] It is important therefore to understand the nature of the change in more detail.

This paper presents updated GBD 2016 estimates for the UK from 1990 to 2016 and for the first time includes results for 150 Upper-Tier Local Authorities in England, as well as for England, Wales, Scotland, and Northern Ireland. These latest GBD results may help to explain the causes of the slowdown in life expectancy improvement since 2010, and are likely to be a guide to rational priority setting for health and social policy, prevention policy, health service planning, and research at national and local level.

Methods

Life expectancy, years of life lost due to premature mortality (YLLs), years lived with disability (YLDs), disability-adjusted life-years (DALYs), and risk factors were estimated in the UK, England, Scotland, Wales, Northern Ireland, and 150 English Upper-Tier Local Authorities from 1990 to 2016 for each location, age group, sex, and year. There are 152 Upper-Tier Local Authorities in England, including county councils, London boroughs, unitary authorities, and metropolitan districts. The City of London and Isles of Scilly were excluded from this analysis due to their small populations, and so data were available for 150 English Upper-Tier Local Authorities.

Years of Life Lost and causes of death

YLLs were computed by multiplying the number of estimated deaths by the standard life expectancy at age of death, derived from the lowest observed mortality rates in any population in the world greater than 5 million (86·6 years at birth for GBD 2016).[2,4] Causes of death were mapped to the 264 GBD 2016 causes of death and age and sex groups. Causes of death were organised in a four-level hierarchy which covered all deaths at all ages. The three cause groups at level one of this hierarchy were: communicable, maternal, neonatal, and nutritional diseases; non-communicable diseases; and injuries. These were broken down into level 2 causes with further disaggregation into level 3 and 4 causes. Ischaemic stroke, for example, was classified as: non-communicable diseases (level 1); cardiovascular diseases (level 2); cerebrovascular disease (level 3); ischaemic stroke (level 4).[3,4]

We compared causes of death at level 3 in the hierarchy to provide a meaningful level for policy makers and health professionals. The exception is cirrhosis, a GBD level 2 cause, which we show as a level 3 cause as further disaggregation into cirrhosis caused by hepatitis, alcohol, or other provides more granular detail than is required for comparison with other level 3 causes. Mortality was based on year of registration. In England and Wales, some deaths may be registered in subsequent years due to delays caused by coroners' inquests, and some of this lag was taken into account in the modelling process, which smoothes over time. All imprecise causes of death, for example ill-defined cancer site or senility, were redistributed to the most likely alternative GBD cause of death.[19] Estimates for each location, year, age, and sex were then generated using a statistical method known as cause of death ensemble modelling (CODEm), which chose an ensemble of models that best reflected all the input data.[3] The resulting estimates were rescaled so that the sum of all cause-specific deaths equalled the total number of deaths from all causes in each age, sex, location, and year category.[3]

Years Lived with a Disability

YLDs were estimated by multiplying the prevalence of each cause and its consequences by a disability weight, corrected for comorbidity.[4] The prevalence of each condition was estimated from published papers, unpublished documents, survey microdata, administrative records of health encounters, registries and disease surveillance systems. Data availability and use by GBD varied between countries. Data sources are available in Appendix Tables 1 to 5 for the different constituent nations in the UK for diabetes, chronic obstructive pulmonary disease, low back and neck pain, skin conditions and depression, and in full from the GBD Data Input Sources Tool.[24]

DisMod-MR 2.1, a Bayesian meta-regression tool, was used to estimate YLDs whilst ensuring consistency between incidence, prevalence, remission, and cause of death rates for each condition.[4,25] A first model was run on all the world's GBD data which produced an initial global fit and estimated coefficients for predictor variables. The global fit was adjusted for predictors and passed down through the GBD geographic levels to country level and then to Upper-Tier Local

Authorities in England in 2016. Disease-specific YLDs were adjusted for comorbidity. Estimates for locations with few or no data were predicted by borrowing information, for example on prevalence of a condition, from other locations, and using covariates to generate comparable estimates across all geographic locations.

Maps of the UK were created for the changes in all-cause, age-standardised YLLs and YLDs over three time periods (1990–1999, 2000–2009, and 2010–2016), using UK census boundary data[26] and geographic information software (ArcGIS).[27] Deprivation in Upper-Tier Local Authorities was measured using the Index of Multiple Deprivation (IMD-2015), a composite measure estimated at small geographical areas, that includes seven domains: income, employment, education, health, crime, barriers to housing and services, and living environment.[28] Correlations between IMD score and YLLs were calculated using Pearson's correlation coefficients on a scale from +1 (perfect positive correlation) to -1 (perfect negative correlation), where scatter plots showed a linear relation.

Disability-Adjusted Life Years

DALYs are the sum of YLLs and YLDs for each location, age group, sex, and year.[5] Risk factor exposure and attributable risk were estimated for 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks.[6] A total of 481 risk-outcome pairs met the GBD study criteria for convincing or probable evidence of a specific risk causing a specific outcome. The attributable burden for each risk was estimated by multiplying the YLLs and YLDs for each outcome of interest by the population attributable fraction (PAF) for the risk-outcome pair.[6] The PAF represents the proportion of DALYs that would have been avoided in a given year if the exposure to a risk factor in the past had been at the theoretical minimum risk exposure level.

Role of the funding source

The GBD 2016 database development, methods improvement, and global analysis is primarily funded by the Bill & Melinda Gates Foundation, which had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all data in the study and had final responsibility to submit the paper.

Results

The leading causes of YLLs in the UK in 2016 for both sexes combined were ischaemic heart disease, trachea, bronchus and lung cancer (subsequently referred to as lung cancer), cerebrovascular disease, chronic obstructive pulmonary disease and dementia; the leading causes of disability (YLDs) were low back and neck pain, skin and subcutaneous diseases, migraine, depressive disorders, and sense organ diseases (Figure 1). The highest burden of age-standardised DALYs was for low back and neck pain (1795 [95% uncertainty interval 1,258–2,356] per 100,000 per year), followed by ischaemic heart disease (1200 [1,155–1,246]). In comparison, the DALY rate for lung cancer was 660 [642-679].

The all-cause age-standardised YLL rate in 2016 was highest in Scotland (11,195 [95% uncertainty interval 10,177-12,389] per 100,000 population) and lowest in England (8941 [8847-9028]), with ischaemic heart disease, lung cancer, cerebrovascular disease, and chronic obstructive pulmonary disease all particularly high in Scotland (Figure 1). Age-standardised YLDs were highest in England (11,054 [8211-14,261]) and Scotland (11,054 [8188-14,304]) and lowest in Wales (10,820 [8030-14,039]), however the range of YLDs across the UK countries only varied by 234 per 100,000 per year compared to a range of 2254 per 100,000 per year for YLLs. England had high YLD rates for low back and neck pain, skin conditions and sense organ disease, and Northern Ireland had high rates for anxiety.

Many conditions were important contributors to burden for both men and women but there were differences. For YLLs, men had higher rates for all ten leading conditions, except for dementia and breast cancer which had higher rates for women; ischaemic heart disease was the leading cause of YLLs in both men and women but the rate was approximately 2·5 times higher in men compared to women; self-harm was the third highest YLL rate for men, but was fourteenth highest for women (age-standardised YLL rate was 153 [95% uncertainty interval 146–162] for UK women in 2016 compared to 546 [422–596] for men); prostate cancer and breast cancer were important causes of premature mortality for men and women, respectively, but breast cancer ranked higher for women than prostate cancer did for men. For YLDs, women had higher rates of disability for all the ten leading conditions, except for sense organ diseases, falls and drug use disorders, which were higher in men.

The ten leading risk factors contributing to YLLs were similar in rank across the four countries of the UK (Figure 2). Although the ranks were similar, the PAF of each varied in size in different countries, such as a higher PAF from tobacco in Scotland, and from alcohol and drug use in Scotland and Northern Ireland compared to the other UK nations.

In England in 2016, age-standardised rates of YLLs for all causes together varied more than two-fold between the highest and lowest IMD-ranked Upper-Tier Local Authorities (from 14,274 [12,791–15,875] per 100,000 people in Blackpool to 6,888 [6,145–7,739] in Wokingham) (Figures 3 and 4). Comparing age-standardised YLL rates for the 15 (10%) most deprived and 15 least deprived Upper-Tier Local Authorities in England (Figure 4), YLLs were markedly and consistently greater in the deprived areas for most conditions. The clearest association with deprivation was seen for all causes, lung cancer, and chronic obstructive pulmonary disease. No association was seen with conditions such as dementia, breast cancer, self-harm, and congenital defects (Appendix Table 6). Some Upper-Tier Local Authorities performed better on YLLs than expected from their level of deprivation, including the London boroughs of Tower Hamlets and Hackney, and Birmingham (Figure 4). It was notable that Upper-Tier Local Authorities in London had generally lower rates of DALYs and YLLs than expected for their level of deprivation throughout the distribution (Appendix Figures 1 and 2).

Variation in age-standardised YLD rates was much less marked than variation in YLLs, with no statistically significant variations (Figures 3 and 5 and Appendix Figure 3). .

More deprived Upper-Tier Local Authorities had higher age-standardised attributable burden of age-standardised all-cause YLLs than less deprived Upper-Tier Local Authorities for most risk factors, although there was variation within and between regions (Figure 6, Appendix Figure 4, and Appendix Figure 5). The PAF for risk factors also varied by Upper-Tier Local Authority for a given level of deprivation (Appendix Figure 6). For example, London Upper-Tier Local Authorities had lower than expected attributable YLL burden particularly for tobacco, dietary risks, and high body mass index, whereas the association between deprivation and alcohol and drug use, and occupational risks, showed less variation between regions.

Between 1990 and 2016, life expectancy at birth for both men and women improved in all four UK countries, but the rate of improvement has slowed since 2010 (Figure 7). Although random variation is expected, 11 out of 150 English Upper-Tier Local Authorities experienced an increase in YLL rates since 2010 (Appendix Figure 7). The trends in annual change in age-standardised YLLs were however different when disaggregated by cause. The reduction in annual rate of improvement for all-cause YLLs since 2010 was driven by the gradual disappearance of what had been sustained annual improvements in YLL rates from ischaemic heart disease, cerebrovascular disease, and to a lesser extent colorectal cancer, lung cancer, and breast cancer (Figure 8). Dementia and chronic obstructive pulmonary disease showed no consistent trend in the rate of change over the period. The flattening of the improvement curve for cardiovascular disease deaths was seen in most age groups but was most apparent in those aged over 85 years, where previous improvements had been greatest (Appendix Figures 8 and 9).

These cause-specific changes in YLL rates are reflected in the risk factor specific estimates of attributable burden. Annual reduction in all-cause age-standardised YLLs attributable to most major risk factors has also slowed since 2010, except for alcohol and drug use which has remained roughly unchanged since 2000 (Appendix Figure 10). The relation between rate of improvement in YLL and deprivation in Upper-Tier Local Authorities has shifted somewhat over time (Appendix Figures 11 and 12). In the period up to 1999, improvement in YLLs were greatest in more affluent Upper-Tier Local Authorities (Pearson's correlation coefficient r = 0·53); from 2000 to 2009, there was no overall relation between rate of improvement and deprivation; from 2010 to 2016, annual improvement has been greater in more deprived Upper-Tier Local Authorities (r = -0·50).

Discussion

Burden of Disease across the UK

The common causes of premature death in 2016 are similar in the four UK countries. However, premature mortality remains substantially higher in Scotland than in England, with higher rates for YLLs from all the leading ten causes, particularly cardiovascular disease, cancer, and cirrhosis. Wales and Northern Ireland have YLL rates in between those of England and Scotland, with some variation by cause. Comparison between UK countries at this level, however, masks substantial variation within those countries, for example between subnational geographical areas in Scotland[29] and England.[11]

Differences between UK countries are generally less for YLDs than for YLLs, with one notable exception being the high rates of YLDs for anxiety disorders in Northern Ireland. High levels of mental health conditions in Northern Ireland are acknowledged and have been attributed to the social and economic legacy of civil conflict.[30,31] Across the countries of the UK, burden due to YLDs surpassed that due to YLLs in England in 2003, in Wales in 2008, and Northern Ireland in 2009, whereas in Scotland YLLs were similar to YLDs in 2016. As death rates fall, people live on with long term, often multiple, conditions, and YLDs rise. This pattern presents a considerable and familiar challenge to statutory health and care services. Finding a way of attenuating or mitigating the impact of this rising burden due to non-fatal conditions and the consequent demand for services must be the key to providing sustainable services in the future.

Patterns shown in Figures 2 and 3 suggest that these long standing differences between the countries of the UK are likely to be substantially due to variations in risk factors and socio-economic deprivation rather than differences in health service organisation and spending. Public health policy and commissioning practices in England are different from those in Scotland, Wales and Northern Ireland, and health service spending has historically been lower in England, because of the different funding formulas adopted by the different nations in the UK.[32-35] However, wider determinants of health such as employment opportunities, housing quality and availability, social cohesion and access to good quality education are likely to have a greater impact on health in localities than National Health Service (NHS) spend.

Our results sometimes differ from the results of a recent study of burden of disease in Scotland, which used different data sources and methods reflecting its different purpose.[16] For example, GBD calculated YLLs using the lowest observed mortality rates in the world and the World Standard Population (WSP). The Scottish burden of disease study used Scottish mortality rates and the European Standard population (ESP). The GBD method estimated a YLL rate for Scotland of 16,891 compared to an estimate of 13,506 in the Scottish study.[16,36] The Scottish study used local data to estimate YLD, resulting in different relative ranks for conditions and larger deprivation gradients in YLD than seen in the Upper-Tier Local Authority analyses presented here.[37]

English Upper-Tier Local Authority estimates

These new local GBD estimates are a highly valuable resource, providing comparable detail down to local level that can support a range of local, regional and national actions. They are likely to be highly informative for regional transformation programmes currently embodied as Sustainability and Transformation Partnerships (STPs) and for developing Integrated Care Systems across England as the NHS in England delivers its 10-year long-term plan from 2019. They demonstrate the strong and persisting relationship between deprivation and premature mortality that varies by condition. Action, which may be local or national, is clearly essential to tackle the social and structural drivers

of ill health if overall health is to improve. Such action is feasible and can result in rapid improvements in health, with reductions in mortality potentially achievable within 1-2 years.[38] Population attributable fractions for major risks also vary considerably between areas, even within the same region. Individual area results such as these will be of interest to local public health leaders and should contribute to setting local priorities for action – recognising that such priorities can never be completely data driven and must reflect local opportunities, assets, and political will. Even for nationally important topics, locally specific data such as these GBD estimates make local advocacy more relevant and more persuasive for local policy makers.

As described in previous GBD studies,[11] London as a region has relatively low mortality for its level of deprivation.[39] One explanation may be that London Upper-Tier Local Authorities have relatively low levels of risk factor exposures, particularly tobacco and dietary risks. Other possible factors are the high educational performance of poor children in London,[40] and selective movement of sicker people out of London, and healthy younger migrants in for work. Access to health services in London may also be a factor, with some evidence that health services in the North East and North West of England are relatively underfunded compared to London.[41] The low mortality may be at least partly an artefact related to inaccuracies in population estimates for London as a consequence of high population turnover, with high levels of internal and international migration. Finally, IMD scores may function differently in London, as for example the housing deprivation domain includes measure of housing affordability, for which London does particularly badly.

Areas of socio-economic deprivation are present throughout the country but are concentrated in the large conurbations of the North.[42] The GBD estimates by Upper-Tier Local Authority show that areas of London and Birmingham both have relatively low levels of attributable risk and YLLs compared to Upper-Tier Local Authorities with similar deprivation in the northern cities of Liverpool and Manchester. This further strengthens the need for specific action to respond to the set of distinct problems that exists in these northern cities.[42,43] There are also important within-country ethnic differences in outcomes that are not considered in this analysis.[44]

Local GBD data on YLDs are more difficult to evaluate as YLD rates are very similar for many important conditions across local areas. The most likely explanation for the large uncertainty around YLDs is the relative lack of local data on prevalence of the major causes of disability, resulting in estimates that are modelled from data on neighbouring areas. The wide uncertainty around disability weights also increases the uncertainty around YLDs. In comparison, YLLs are based on annual cause of death data from vital registration that show much less heterogeneity between locations and over time compared to non-fatal data sources. To guide an appropriate response, much better local data are needed on causes of disability. These could come from health care datasets, surveys, or other sources including covariates. However, utilisation data can be biased due to supply factors (such as unavailability for some populations) and surveys may be expensive.

Trends in mortality

Official mortality statistics show that the long-standing trend for annual improvement in life expectancy in England and Wales has slowed since 2011.[45] Infant mortality rates have increased slightly since 2014, although they remain at historically low levels.[46] The latest GBD results confirm this effect for YLLs in all the UK countries. As this change in trend has become established, it has generated considerable speculation about its cause or causes but little if any firm evidence. Watkins et al. found an apparent correlation with levels of total public spending on health and on social care.[23] Hiam et al. suggested that in the absence of other plausible causes, cuts to the UK health and social care system were the most likely explanation.[22] Marked fluctuations in numbers of deaths

from year to year, but not the overall trend, can often be attributed to levels of circulating flu.[47] Raleigh points out that many different factors are likely to be involved, including a cohort effect with the gains from reducing smoking already substantially realised, and the rise of comorbidity.[48] A similar change seems to have occurred in a number of other countries at a similar time,[47,49] which argues against economic or health service factors unique to the UK, and suggests something more fundamental is going on related to trends in demography, epidemiology, or socio-economic factors seen in a number of other countries. The new GBD data reported here show that the change in overall trend is mainly driven by a set of distinct condition-specific trends predominantly in cardiovascular diseases and some cancers. The worsening trend in YLLs to some cancers is a concern given evidence that survival for some common cancers is already worse in the UK than in some comparable countries.[50] Population-level period factors such as the global economic crisis since 2008, impact of fiscal austerity in the UK or the quality and capacity of local services could conceivably operate differentially on specific conditions through risk factor exposures, health care provision, or certain social determinants of health.[51]

More affluent areas experienced greater annual mortality improvements before 2000, but this changed after 2010 when the national slowdown in mortality improvement was, counterintuitively, most marked in relatively affluent areas (Appendix Figures 7 and 11). This is a new finding and contrasts with evidence from some previous recessions that mortality rates tend to improve during economic downturns, perhaps due to declines in risky behaviours.[43] The reasons for this slowdown in mortality improvement in less deprived areas are not clear, and further research is needed both into the relation between deprivation and mortality trends since 2010, and the many possible contributory factors before conclusions can be drawn. Changes in deprivation for older people, unemployment, and binge drinking have been shown to be important in explaining life expectancy differences.[52] Together, these findings seem to suggest that the overall change in trend in YLLs is the result of an evolving epidemiological transition with multiple condition-specific and possibly cohort-based components, including changing exposure to certain risk factors.

Strengths and limitations

Where data were not available for a particular location, GBD modelled estimates using data from other locations and predictive covariates. The availability of accurate local data on mortality was better than for morbidity, which may explain why the variation in YLD rates was much less marked across the UK than variation in YLLs. Data sources used to produce these 2016 estimates of YLD for the four UK countries for the example conditions of diabetes mellitus, chronic obstructive pulmonary disease, low back and neck pain, skin and subcutaneous diseases, and depressive disorders show that different sources were used for different locations, and therefore some of the variation reported may be due to different data sources rather than true underlying variation (Appendix Tables 1 to 5). A full list of data input sources for GBD 2016 is available elsewhere.[24]

Where new data or changes in modelling lead to changes in estimates of disease burden, a strength of the GBD approach is that all previous estimates are recalculated using the newest model. For example, the apparent increase in skin disease in GBD 2016 compared to 2013 was due to a change in the method of estimating severity for acne, to award higher disability to a subset of cases with more severe disease, whereas in the past all cases were deemed to have mild disability,[53] and inclusion of new, more accurate data for dermatitis.

The decision to use a global, European, or UK-specific condition severity distribution affects YLD estimates. The data sources on variations in severity distribution by age or location are sparse; this is a limitation as one would expect substantial variation in severity for conditions for which effective

treatments exist. The way deprivation is measured varies across the four countries of the UK, but previous work by Public Health England suggests that this does not substantially affect the relation between deprivation and prevalence, at least for cancer.[54] The relation between risk factors and outcomes may differ across areas, which may lead to underestimation or overestimation of attributable risk in some areas.[55]

Diabetes mellitus, asthma, skin disease, and chronic obstructive pulmonary disease are examples of conditions where GBD and alternative UK estimates differ in 2016. These differences arise mainly from the use of different data sources and disease definitions, and partly from the methods used to model the data in GBD. For example, primary care electronic health record data in England (The Quality and Outcomes Framework and The Health Improvement Network) as well as reported data from the Health Survey for England all show a rising diabetes prevalence (consistent with other high-income countries),[56-58] whereas GBD used data from research papers for diabetes prevalence, which show a flat or falling prevalence rate.[24] It has been difficult to reconcile these differences partly because data governance concerns prevent even anonymised records from UK primary care being made available to the GBD project.

The choice of which GBD level to use when presenting results changes the rank order of conditions. We have presented results by level 3 conditions, which gives low back and neck pain and skin and subcutaneous diseases as the leading UK causes of YLDs. At level 2, musculoskeletal and mental disorders are the leading causes (appendix figure 13).[3,4] The distinction between behavioural and metabolic risk factors (Figure 2) is not absolute, as behavioural factors such as physical activity and diet clearly affect metabolic factors such as high blood pressure and body mass index.

Implications for research and policy

The results overall strongly suggest that all countries of the UK could further reduce the burden of disease through effective prevention. For example, the continued dominance of cardiovascular disease in GBD argues for renewed efforts to deliver systematic programmes to reduce risk factors such as high body mass index, high fasting glucose, high blood pressure and high cholesterol. Other conditions that feature highly in GBD estimates for the UK such as cancers and respiratory disease can be addressed by tackling behaviours such as smoking and eating unhealthy foods. Good progress has been made in some areas, notably in reducing smoking rates to historic lows in all countries of the UK, but there is scope to do so much more in almost all areas of primary prevention.

Overall, some two-thirds of improvements to date in premature mortality can be attributed to population-wide decreases in smoking, cholesterol, and blood pressure, and approximately one-third due to improved therapies.[59] Health services need to recognise therefore that prevention is a core activity rather than an optional extra to be undertaken if resources allow. In many cases of course, the causes of ill health and the behaviours that cause it lie outside the control of health services. For example, obesity, sedentary behaviour and excess alcohol use all feature strongly in GBD as risk factors for diseases such as musculo-skeletal disease, liver disease and poor mental health. The GBD results therefore also argue for policies and programmes that deter the food industry from a business model based on cheap calories, that promote and sustain healthy built and natural environments, and that encourage a heathy drinking culture.

The same level of attention that has previously been given to prevention of cardiovascular disease and cancer now also needs to be directed at the other major causes of YLLs, such as liver disease and dementia, and associated risk factors including unhealthy diets, alcohol, air pollution, and drug

misuse. Unfortunately, adequate research on effective population-level prevention interventions in these areas is much more limited, but by no means absent.

Public health policy needs also to respond actively and rapidly to the shift in relative burden from mortality towards morbidity. More evidence is needed to support population-level interventions to address the causes and effects of conditions such as musculoskeletal disease, poor mental health, and sensory impairments, and there is an urgent need for research and action to prevent further increases in burden due to disability from these conditions, and to understand the economic impact. Timely access to health services is important for treatable conditions such as vision loss caused by cataract, glaucoma, and diabetic retinopathy. The promotion of musculoskeletal and mental health are key components of the recent WHO Europe Action Plan for Noncommunicable Disease to avoid premature death and significantly reduce disease burden.[60]

There are still concerns with the accuracy of local estimates of ill health, but the hierarchical ranking of YLD by Upper-Tier Local Authority can inform better local targeting of health services. For future iterations of GBD, the use of primary care electronic health records, including prescribing, should be used to refine disease prevalence estimates and improve consistency between GBD and other reliable estimates, while recognising that utilisation rates have known weaknesses as measures of need.[61] Health care utilisation data remain underutilised for descriptive epidemiology. Their value can be greatly enhanced if linked to population survey data and death records where the strengths of each data type (good diagnostic information in health records; data on risk factors and severity of disease from surveys) enhance their value for population health measurement. There are excellent examples of data linkage for audit (for example the Sentinel Stroke National Audit programme), research (for example the Caliber project at University College London), and policy (for example NHSDigital linked hospital and mortality data), but still no linked health data that can inform comparable estimates of burden of disease at local level. Further research on disease burden at Upper-Tier Local Authority level should explore the burden of different diseases at a more specific level of diagnosis, and explore the impact of age disaggregation, for example in children and in different age groups for older people.

Overall this study provides a timely input into the new long term plan for the NHS in England and similar planning processes both in the other countries of the UK, and at local level in England. The new local estimates will increase the relevance of GBD for many users, highlighting where local levels of burden and risk factors may require tailored local solutions, for example for diet and occupational risks (Appendix Figures 4, 5 and 6). National results reveal the need for effective primary prevention to reduce the substantial attributable risks due to smoking, unhealthy diets, obesity and excess alcohol use, which lead to massive burden from heart disease, cancer and the multiple co-existing conditions that reduce independence in older people. Resource allocation in health services needs to continually adapt to the increasing burden from non-fatal conditions such as musculoskeletal conditions, depressive disorders, sensory loss and skin diseases. Significant improvement in the quality and completeness of available morbidity data is needed to support implementation of such a change in national health policy.

Finally, we hope that this study will inform similar analyses across Europe supported by the newly formed WHO European Burden of Disease Network.[62]

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Authors' contributions

NS, JF and JN prepared the first draft. JN, AD and CJLM conceived the study and provided overall guidance. All other authors provided data, developed models, reviewed results, initiated modelling infrastructure, and/or reviewed and contributed to the report.

Conflict of interest statement

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Figure 1: Age-standardised years of life lost (YLLs), years lived with disability (YLDs), and disability-adjusted life years (DALYs) rate per 100,000 population for all causes combined and leading ten causes in UK countries, women, men, and both sexes combined, 2016

		United Kingdom	England	Scotland	Wales	Northern Ireland
Both YLLs	All causes	9222	8941	11195	10080	10090
	Ischaemic heart disease	1099	1040	1457	1318	1344
	Trachea, bronchus, and lung cancer	649	623	856	701	699
	Cerebrovascular disease	452	431	630	485	501
	Chronic obstructive pulmonary disease	419	408	512	437	425
	Alzheimer's disease and other dementias	352	346	378	402	378
	Self-harm	349	326	507	410	495
	Lower respiratory infections	337	336	337	322	390
	Cirrhosis and other chronic liver diseases	318	302	460	349	294
	Colon and rectum cancer	295	286	338	337	338
	Breast cancer	276	271	303	302	288
Female YLLs	All causes	7365	7164	8839	7905	7750
	Ischaemic heart disease	610	570	862	747	773
	Trachea, bronchus, and lung cancer	541	516	757	571	543
	Breast cancer	526	517	572	576	548
	Cerebrovascular disease	401	380	567	433	449
	Alzheimer's disease and other dementias	368	361	393	415	390
	Chronic obstructive pulmonary disease	364	350	472	384	375
	Lower respiratory infections	283	282	279	278	328
	Colon and rectum cancer	234	227	275	255	263
	Congenital birth defects	224	221	216	233	312
	Cirrhosis and other chronic liver diseases	223	212	328	244	205
Male YLLs	All causes	11236	10864	13805	12423	12651
	Ischaemic heart disease	1637	1557	2129	1949	1986
	Trachea, bronchus, and lung cancer	772	743	976	847	878
	Self-harm	546	509	767	670	836
	Cerebrovascular disease	511	488	702	546	561
	Chronic obstructive pulmonary disease	489	479	570	506	495
	Cirrhosis and other chronic liver diseases	415	395	601	459	387
	Lower respiratory infections	404	402	411	377	472
	Colon and rectum cancer	363	352	410	428	422
	Alzheimer's disease and other dementias	323	317	352	379	355

	Prostate cancer	308	307	309	327	311
Both YLDs	All causes	11035	11054	11054	10820	10827
	Low back and neck pain	1795	1820	1654	1692	1645
	Skin and subcutaneous diseases	1036	1043	1003	989	977
	Migraine	732	719	809	785	786
	Depressive disorders	668	664	702	673	686
	Sense organ diseases	651	667	570	559	593
	Anxiety disorders	442	435	464	451	567
	Falls	364	364	374	357	361
	Oral disorders	354	355	353	347	347
	Asthma	354	348	397	368	371
	Other musculoskeletal disorders	322	323	317	317	295
Female YLDs	All causes	11741	11773	11667	11451	11546
	Low back and neck pain	2023	2056	1841	1885	1847
	Skin and subcutaneous diseases	1149	1158	1112	1095	1082
	Migraine	965	946	1086	1045	1043
	Depressive disorders	791	784	850	796	822
	Sense organ diseases	627	641	556	546	574
	Anxiety disorders	567	557	595	582	729
	Other musculoskeletal disorders	375	375	379	377	360
	Asthma	374	367	430	392	403
	Oral disorders	366	367	366	360	360
	Falls	325	326	333	315	308
Male YLDs	All causes	10324	10331	10421	10188	10093
	Low back and neck pain	1557	1576	1454	1491	1432
	Skin and subcutaneous diseases	923	930	893	884	870
	Sense organ diseases	678	695	587	574	615
	Depressive disorders	543	543	548	548	546
	Migraine	496	491	521	523	522
	Falls	400	399	411	397	413
	Drug use disorders	371	362	472	423	249
	Oral disorders	341	342	339	334	333
	Asthma	333	330	363	344	338
	Anxiety disorders	317	313	330	319	402
Both DALYs	All causes	20257	19995	22249	20900	20917
	Low back and neck pain	1795	1820	1654	1692	1645
	Ischaemic heart disease	1200	1139	1567	1428	1471
	Skin and subcutaneous diseases	1060	1068	1028	1012	999
	Migraine	732	719	809	785	786
	Depressive disorders	668	664	702	673	686
	Trachea, bronchus, and lung cancer	660	633	870	712	711
	Sense organ diseases	651	667	570	559	593
	Cerebrovascular disease	598	570	825	650	657
	Chronic obstructive pulmonary disease	519	507	618	533	521
	Drug use disorders	465	443	714	531	304
Fe	All causes	19106	18937	20506	19356	19296
	Low back and neck pain	2023	2056	1841	1885	1847

	Skin and subcutaneous diseases	1174	1184	1136	1118	1104
	Migraine	965	946	1086	1045	1043
	Depressive disorders	791	784	850	796	822
	Ischaemic heart disease	688	647	945	829	869
	Sense organ diseases	627	641	556	546	574
	Anxiety disorders	567	557	595	582	729
	Breast cancer	566	556	618	624	595
	Trachea, bronchus, and lung cancer	550	525	769	580	552
	Cerebrovascular disease	544	517	755	587	600
Male DALYs	All causes	21559	21195	24226	22611	22744
	Ischaemic heart disease	1763	1680	2268	2089	2147
	Low back and neck pain	1557	1576	1454	1491	1432
	Skin and subcutaneous diseases	946	953	917	907	892
	Trachea, bronchus, and lung cancer	785	755	992	860	892
	Sense organ diseases	678	695	587	574	615
	Cerebrovascular disease	661	631	909	724	724
	Drug use disorders	658	617	1118	789	389
	Chronic obstructive pulmonary disease	605	595	692	617	608
	Self-harm	554	517	775	678	844
	Depressive disorders	543	543	548	548	546

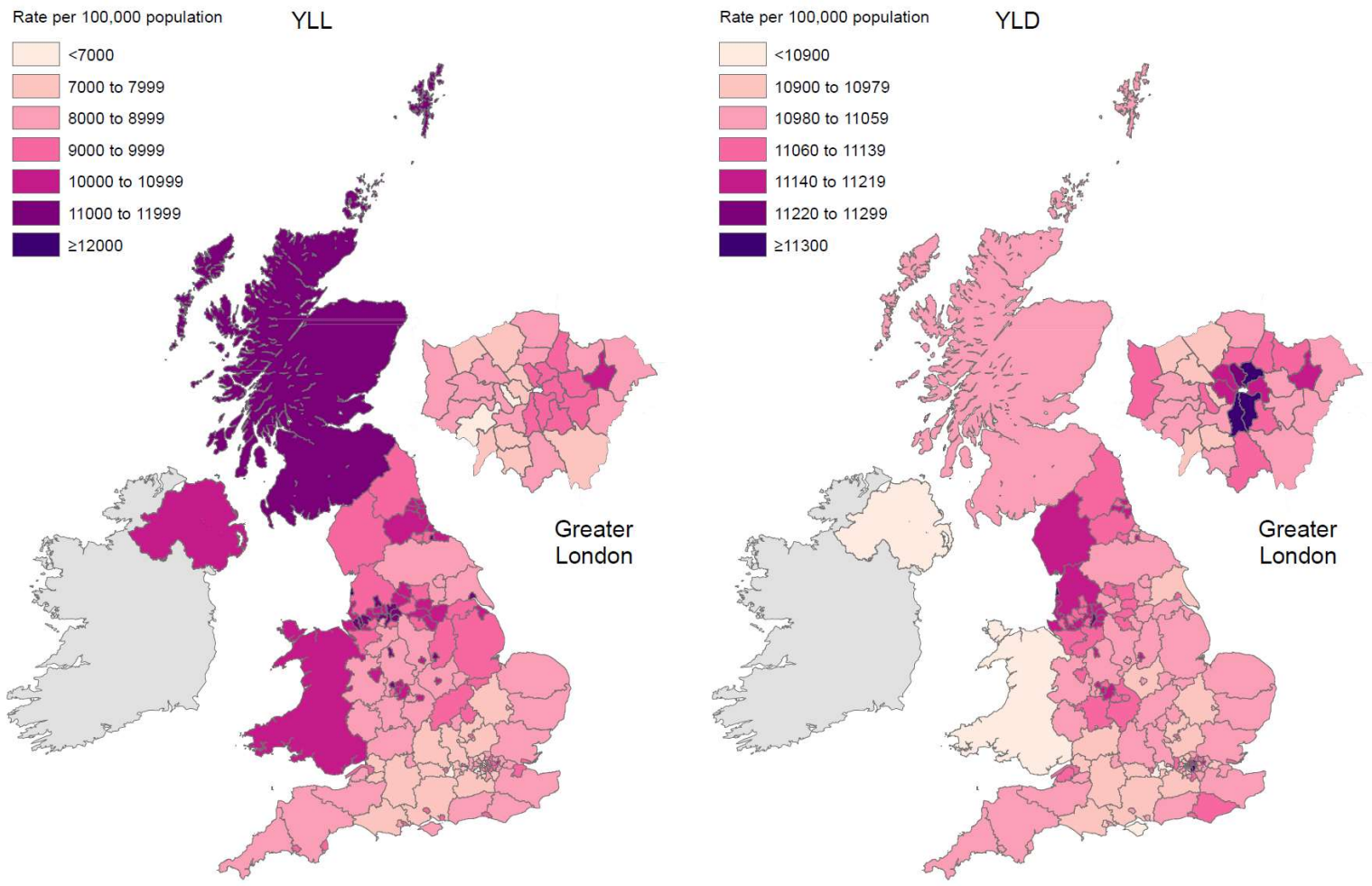
	Significantly lower than UK mean (95%UI)
	Significantly higher than UK mean (95%UI)

Figure 2: Population attributable fraction (PAF) for risk factors for all-cause years of life lost (YLLs) rate per 100,000 population for England, Scotland, Wales, and Northern Ireland, both sexes, 2016

Rank	England	PAF (%)	Scotland	PAF (%)	Wales	PAF (%)	Northern Ireland	PAF (%)
1	Tobacco	19.26	Tobacco	22.76	Tobacco	20.31	Tobacco	20.01
2	Dietary risks	14.41	Dietary risks	16.12	Dietary risks	16.35	Dietary risks	15.88
3	High blood pressure	13.04	High blood pressure	14.62	High blood pressure	15.53	High blood pressure	14.99
4	High body mass index	9.57	Alcohol and drug use	12.98	High body mass index	9.85	Alcohol and drug use	11.50
5	Alcohol and drug use	9.52	High body mass index	10.70	Alcohol and drug use	9.59	High body mass index	9.97
6	High total cholesterol	7.44	High total cholesterol	8.49	High total cholesterol	8.07	High total cholesterol	8.35
7	Occupational risks	4.85	High fasting plasma glucose	5.02	High fasting plasma glucose	5.20	High fasting plasma glucose	5.18
8	High fasting plasma glucose	4.84	Occupational risks	4.63	Occupational risks	4.55	Occupational risks	4.30
9	Air pollution	4.04	Air pollution	3.87	Air pollution	3.91	Air pollution	3.58
10	Low physical activity	2.16	Impaired kidney function	2.48	Low physical activity	2.03	Low physical activity	2.52

Behavioural | Environmental and occupational | Metabolic

Figure 3. All-cause age-standardised years of life lost (YLLs) and years lived with disability (YLDs) rate per 100,000 population by UK country and English Upper Tier Local Authorities, 2016



Data for the City of London and Isles of Scilly not available. Source: Institute for Health Metrics and Evaluation 2017. Contains National Statistics data © Crown copyright and database right 2017. Ireland outline © 2018 GADM. NISRA: Website: www.nisra.gov.uk. Contains NRS data © Crown copyright and database right 2017. Contains OS data © Crown copyright and database right 2017.

Figure 4. Age-standardised years of life lost (YLLs) rate per 100,000 population for the 20 causes with the highest national YLL burden in order of decreasing burden, in the 15 (10%) most deprived and 15 (10%) least deprived Upper-Tier Local Authorities (UTLAs) in England, both sexes, 2016

Upper tier local authority	IMD score	All causes	Ischaemic heart disease	Trachea, bronchus, and lung cancer	Chronic obstructive pulmonary disease	Cerebrovascular disease	Lower respiratory infections	Alzheimer's disease and other dementias	Cirrhosis and other chronic liver diseases	Self-harm	Colon and rectum cancer	Breast cancer	Neonatal preterm birth	Congenital birth defects	Road injuries	Drug use disorders	Other cardiovascular and circulatory ..	Pancreatic cancer	Cirrhosis and other chronic liver diseases ..	Other neoplasms	Oesophageal cancer	Brain and nervous system cancer
Most deprived 15 UTLAs																						
Blackpool	42	14274	1708	1012	718	761	570	359	742	665	429	374	359	264	293	301	286	234	355	211	225	170
Kingston upon Hull, City of	41	11501	1448	1086	732	602	450	353	336	443	357	305	257	224	199	172	208	198	163	190	179	170
Knowsley	41	11033	1379	1112	746	509	481	354	362	256	356	293	218	269	192	178	171	191	175	171	195	150
Liverpool	41	11607	1268	1094	691	525	511	356	537	304	361	285	326	274	176	429	199	189	263	165	198	130
Manchester	41	11729	1483	1045	738	598	468	353	531	316	343	275	345	241	147	352	240	192	267	150	186	124
Middlesbrough	40	11693	1398	1073	670	629	494	355	413	415	396	310	271	223	209	164	193	201	200	224	171	144
Birmingham	38	10369	1254	690	482	490	391	347	379	280	304	263	571	329	159	277	176	176	187	150	160	122
Nottingham	37	11313	1337	876	635	533	420	353	421	364	352	305	417	359	171	146	229	206	209	183	176	151
Tower Hamlets	36	9629	1186	849	560	392	332	334	338	226	268	219	286	218	124	354	186	184	174	138	136	126
Barking and Dagenham	35	10617	1364	944	634	447	471	348	319	290	308	325	245	261	175	71	209	204	157	204	152	151
Hackney	35	9388	1128	705	435	368	327	333	355	237	244	242	354	169	136	323	187	176	180	142	126	136
Sandwell	35	10870	1346	791	563	559	407	355	405	331	327	306	418	351	193	124	192	193	196	165	168	132
Blackburn with Darwen	34	11464	1619	806	671	595	436	357	378	436	351	271	357	231	211	269	181	186	183	179	196	171
Rochdale	34	11150	1497	852	634	619	440	360	406	389	313	303	276	235	203	226	205	188	195	183	175	143
Stoke-on-Trent	34	11847	1335	918	660	484	413	358	388	357	374	317	526	459	190	254	222	211	188	207	202	153
England (95% uncertainty interval)	**NA**	**8941 (8847-9029)**	**1040 (1018-1071)**	**623 (608-642)**	**408 (391-445)**	**431 (407-452)**	**336 (314-356)**	**345 (296-411)**	**302 (292-312)**	**326 (278-359)**	**286 (276-298)**	**271 (261-282)**	**262 (237-273)**	**238 (224-276)**	**170 (163-180)**	**167 (152-177)**	**174 (168-180)**	**170 (165-175)**	**147 (135-159)**	**149 (143-154)**	**143 (136-149)**	**139 (112-148)**
Least deprived 15 UTLAs																						
Bath and North East Somerset	12	7512	807	459	262	358	263	343	223	290	258	234	147	249	138	120	154	158	108	138	127	156
Central Bedfordshire	12	7798	895	527	361	348	299	342	221	262	260	248	143	202	184	118	155	151	107	131	133	137
Hampshire	12	7438	790	474	298	360	269	340	214	291	254	258	135	184	148	147	152	160	103	134	120	136

Hertfordshire	12	7601	848	523	338	360	324	340	208	247	257	263	180	168	134	148	165	161	102	122	114	130
Oxfordshire	12	7494	752	470	302	347	285	340	241	280	265	248	201	205	153	128	150	161	118	131	121	136
Kingston upon Thames	11	7196	830	501	293	297	311	335	265	300	210	227	172	233	120	53	138	137	132	111	107	129
South Gloucestershire	11	7389	818	478	285	321	251	343	224	282	244	229	158	245	159	87	131	144	108	137	136	153
Bracknell Forest	10	7596	811	562	327	365	339	349	244	192	239	246	157	225	167	43	147	171	119	129	123	129
Buckinghamshire	10	7384	773	418	282	327	274	337	213	292	240	254	229	220	158	133	155	160	103	134	108	139
Richmond upon Thames	10	6734	671	453	284	242	253	327	283	272	207	216	173	180	118	83	127	129	140	107	101	117
Rutland	10	8131	1037	425	341	389	263	342	209	266	215	313	274	303	175	114	141	98	100	164	85	103
West Berkshire	10	7780	793	513	329	375	306	343	288	306	283	255	158	236	165	23	150	172	140	144	131	150
Surrey	9	7154	722	449	284	335	313	340	223	262	247	243	169	192	131	104	149	155	109	120	112	134
Windsor and Maidenhead	9	7748	904	522	306	385	351	345	271	330	266	245	204	135	172	54	144	156	133	121	120	137
Wokingham	6	6888	723	406	261	321	297	342	213	293	239	200	213	170	142	47	120	136	104	129	114	135

	Significantly lower than England mean (95%UI)
	Significantly higher than England mean (95%UI)

Figure 5. Age-standardised years lived with disability (YLDs) rate per 100,000 population for the 20 causes with the highest national YLD burden in order of decreasing burden, in the 15 (10%) most deprived and 15 (10%) least deprived Upper Tier Local Authorities (UTLAs) in England, both sexes, 2016

	IMD score	All causes	Low back and neck pain	Skin and subcutaneous diseases	Migraine	Depressive disorders	Sense organ diseases	Anxiety disorders	Falls	Oral disorders	Asthma	Other musculoskeletal disorders	Drug use disorders	Diabetes mellitus	Bipolar disorder	Osteoarthritis	Schizophrenia	Cerebrovascular disease	Other mental disorders	Autism spectrum disorders	Upper respiratory infections	Other cardiovascular and circulatory diseases
Most deprived 15 UTLAs																						
Blackpool	42	11300	1820	1019	718	661	695	436	459	356	359	291	343	243	206	177	155	152	141	132	131	125
Kingston upon Hull, City of	41	11075	1819	1029	714	661	674	434	372	356	353	308	254	222	208	176	160	149	142	136	131	119
Knowsley	41	11165	1835	1037	732	668	666	442	394	354	348	298	312	221	210	179	159	144	140	132	131	99
Liverpool	41	11133	1822	1041	716	657	660	346	413	353	346	309	388	226	209	178	143	146	142	134	131	111
Manchester	41	11280	1816	1050	711	659	634	433	439	351	353	292	356	237	207	177	161	156	142	133	131	131
Middlesbrough	40	11142	1825	1029	720	663	679	436	381	359	349	342	254	234	208	184	158	149	141	133	131	110
Birmingham	38	11141	1823	1035	720	664	667	437	420	354	344	298	347	241	211	174	160	144	141	135	131	105
Nottingham	37	11182	1819	1041	711	661	766	433	381	356	347	310	259	240	208	176	166	149	142	135	131	132
Tower Hamlets	36	11156	1795	1071	704	657	592	430	366	347	391	337	325	266	209	173	171	154	143	137	131	121
Barking and Dagenham	35	11183	1816	1112	725	666	687	438	351	355	378	325	245	214	211	175	159	131	141	149	131	111
Hackney	35	11331	1806	1082	718	663	584	436	372	346	391	362	328	288	208	174	174	161	141	134	131	124
Sandwell	35	11146	1821	1023	719	664	685	436	385	356	350	311	303	252	210	174	159	146	141	135	131	116
Blackburn with Darwen	34	11139	1822	1023	718	662	685	435	375	358	351	345	329	230	207	178	158	149	141	134	131	99
Rochdale	34	11170	1825	1022	722	664	695	437	368	356	349	317	315	231	208	178	157	147	141	134	131	117
Stoke-on-Trent	34	11176	1817	1026	715	661	677	435	471	354	346	327	351	212	207	174	159	142	142	135	131	113
England (95% uncertainty interval)	**NA**	**11054 (8211-14261)**	**1820 (1277-2387)**	**1043 (705-1482)**	**719 (463-1007)**	**664 (454-910)**	**667 (462-922)**	**435 (304-591)**	**364 (247-509)**	**355 (217-551)**	**348 (228-499)**	**323 (216-461)**	**276 (200-356)**	**215 (146-300)**	**211 (131-313)**	**176 (116-254)**	**161 (120-201)**	**139 (99-176)**	**141 (96-202)**	**137 (93-192)**	**131 (78-203)**	**127 (87-178)**
Least deprived 15 UTLAs																						
Bath and North East Somerset	12	10990	1821	1044	719	666	663	436	351	355	334	399	220	203	214	174	163	135	141	140	132	146
Central Bedfordshire	12	10948	1819	1034	721	665	673	436	347	354	339	303	248	215	212	177	162	133	141	139	131	140
Hampshire	12	10966	1820	1041	722	666	654	437	359	353	355	305	258	203	213	175	164	135	141	139	132	135
Hertfordshire	12	10956	1822	1047	723	667	645	438	350	354	338	301	263	205	214	177	164	137	141	139	132	139
Oxfordshire	12	10987	1815	1132	716	664	642	435	351	354	335	318	254	213	212	175	137	135	142	154	131	140
Kingston upon Thames	11	10944	1812	1053	721	666	650	438	333	354	380	333	247	193	215	174	164	130	141	139	132	117
South Gloucestershire	11	10934	1819	1046	718	665	638	436	343	356	335	390	215	202	212	174	165	135	142	141	131	119
Bracknell Forest	10	10926	1818	1049	722	666	636	437	370	356	337	288	230	206	214	175	165	138	141	139	132	130
Buckinghamshire	10	10983	1821	1044	723	667	648	437	365	355	336	298	247	200	213	175	164	134	141	139	132	143

Richmond upon Thames	10	10988	1817	1060	726	668	645	440	345	354	378	344	249	194	216	175	164	126	141	138	132	132
Rutland	10	11006	1814	1019	703	657	679	429	390	357	336	285	259	182	211	177	162	138	143	143	131	156
West Berkshire	10	10929	1817	1049	720	666	623	436	359	355	342	311	230	217	213	175	167	143	142	140	132	140
Surrey	9	10960	1819	1093	721	666	639	437	347	354	335	314	242	196	213	175	165	135	141	140	132	126
Windsor and Maidenhead	9	10876	1819	1054	720	665	627	436	360	357	338	297	232	207	214	175	166	142	142	140	132	132
Wokingham	6	10887	1819	1051	722	668	637	437	367	354	336	291	228	202	217	175	166	136	141	141	132	133

Note: no estimates are statistically significantly different from the England mean

Figure 6: Attributable risk for age-standardised all-cause years of life lost (YLLs) rate per 100,000 population for nine major risk factors, and Upper Tier Local Authority (UTLA) level Index of Multiple Deprivation (IMD) Score, for UTLAs in three regions of England, 2016

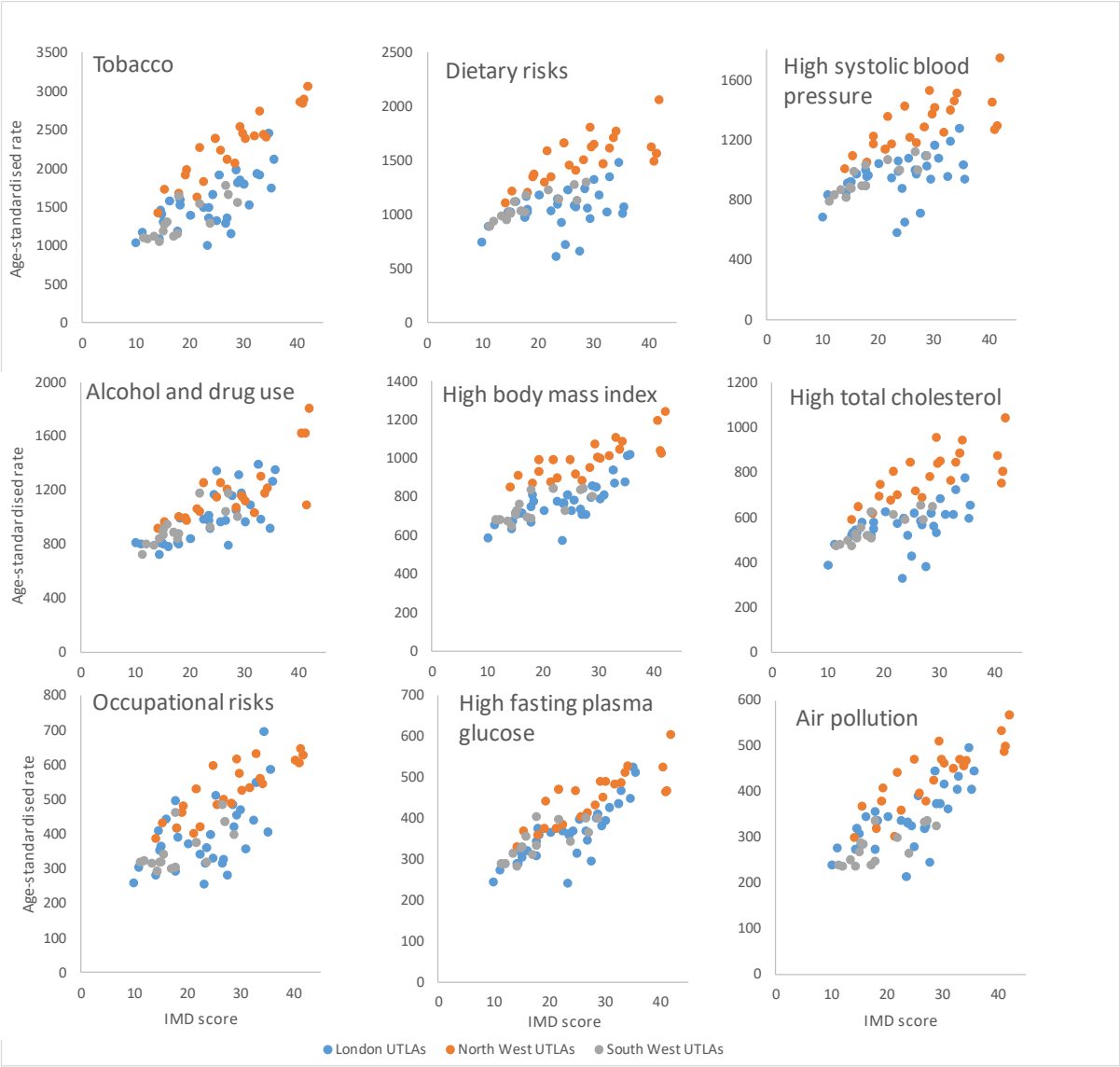


Figure 7: Life expectancy at birth for England, Scotland, Wales, and Northern Ireland between 1990 and 2016, men and women

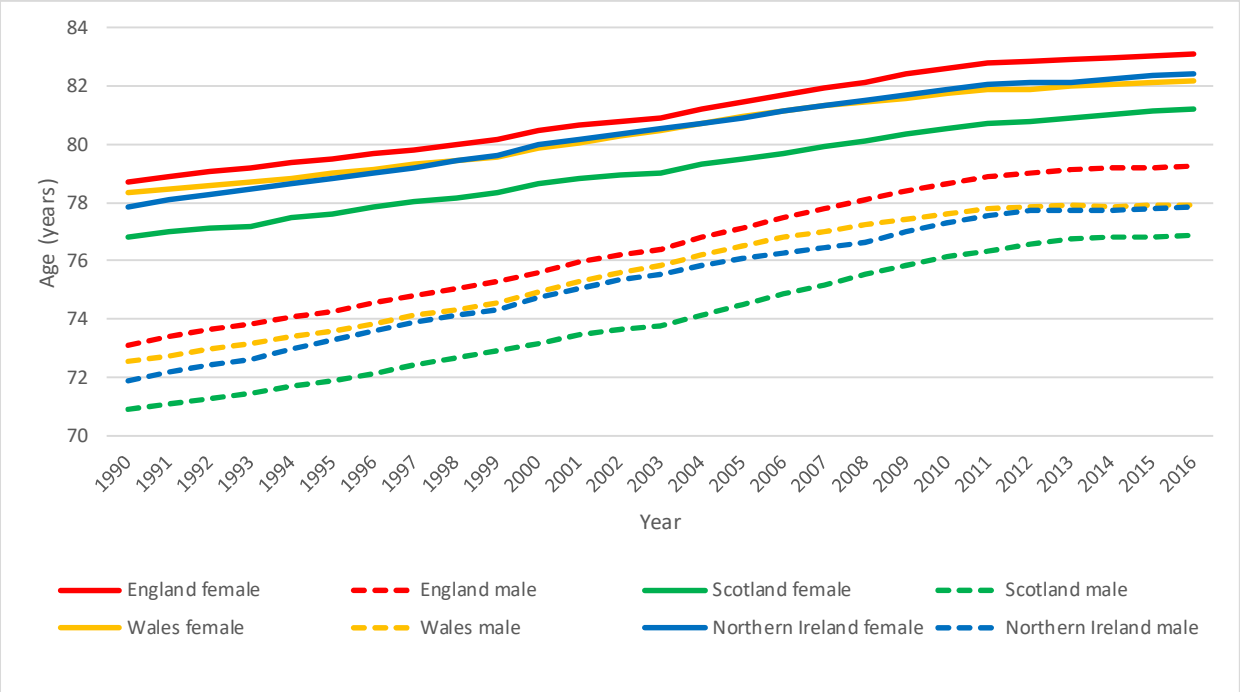
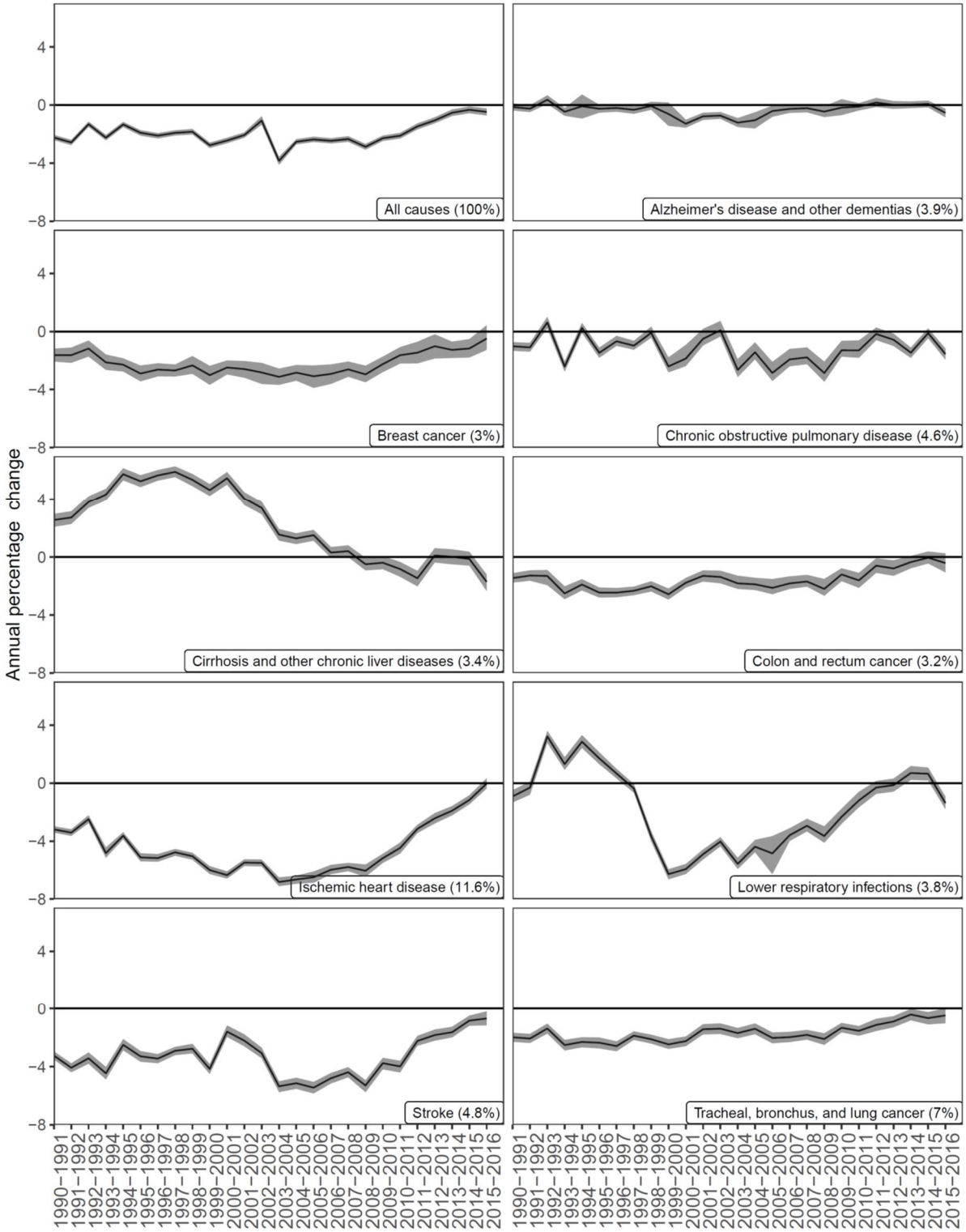


Figure 8. Annual percentage change and 95% uncertainty range in years of life lost (YLLs) rate per 100,000 population for the nine causes with the highest national burden, from 1990 to 2016 in England, with the percentage that each condition contributes to all-cause YLLs in brackets.



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